

SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS, AUGUST, 1916.

By ALFRED J. HENRY, Professor in Charge.

[Dated: Weather Bureau, Washington, Sept. 26, 1916.]

A large majority of the floods of record in August, 1916, crested in July, but the river remained above flood stage into the succeeding month. (See tables 2-4). August as a whole was practically free from severe floods in the large streams, although heavy local rains caused destructive floods in certain small streams in West Virginia and the vicinity of Hannibal, Mo.

Floods in West Virginia.

The most destructive of these local floods occurred on August 9, 1916, in Cabin Creek, an insignificant mountain stream less than 20 miles in length that flows northward and empties into the Great Kanawha River a short distance above Charleston, W. Va.

Severe floods also occurred in the adjacent drainage to the west—viz, in Coal Creek, a much larger stream than Cabin Creek—on the same day due to the same rain-storm. Coal Creek is a little less than 60 miles in length rising in Raleigh County and flowing thence northwesterly parallel to the Guyandotte River and emptying into the Great Kanawha a little above Lock No. 7. Little Coal Creek, a tributary of Coal Creek, carries the drainage of the western portion of the watershed directly east of the Guyandotte divide.

No measurements of either rainfall or run-off were made in Cabin Creek watershed. The rainfall was measured at the cooperative station of Madison, Boone County, W. Va., in the watershed of Little Coal Creek and together with that of Charleston and Kanawha Falls, W. Va., both special river stations of the Weather Bureau, are given in the table below.

We are indebted to the United States Engineer officer at Charleston, W. Va., for a copy of the rainfall at Lock No. 2 in the Great Kanawha. These four stations are not far distant from the scene of the floods, but it is quite evident that none of the measurements gives any idea of the amount of the precipitation that occurred directly over the watershed. The cooperative observer at Madison, Mr. S. E. Bradley, states that 6 inches of rain fell at a point 12 miles northwest of his station; also at a point the same distance east.

TABLE 1.—Precipitation at West Virginia points.

Stations.	August, 1916.		
	9	10	11
	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>
Madison.....	3.20	0	0
Charleston.....	1.10	0	0
Charleston, Lock No. 2.....	1.05	0	0
Kanawha Falls.....	1.50	0	0

The Great Kanawha, as gaged at Charleston, showed a rise of 1.3 feet on the 9th and a further rise of 3.3 feet on the 10th, followed by a fall of 2.5 feet on the 11th. There are no gaging stations on the Great Kanawha be-

tween Charleston and its mouth at Point Pleasant, W. Va. The Ohio at the last named point showed a rise of 5.5 feet on the 10th, which may be considered as due to the flood waters in the Great Kanawha.

Cabin Creek, along which the destruction was greatest, is lined with hamlets mainly composed of coal miners' cottages; it was in these hamlets that the greatest loss of life occurred. Press dispatches 3 days after the flood place the loss of life at less than 50, although according to the press dispatches of the day before 60 dead bodies had already been recovered and others were unaccounted for.

Property loss, originally placed at \$5,000,000, was reduced by later estimates to \$575,000.

Flood in Missouri.

A severe local flood occurred at Hannibal, Mo., about 1:30 o'clock a. m., August 15. The following account has been prepared by Meteorologist B. L. Waldron of the Weather Bureau office at Hannibal, Mo.

The excessive rains of the night of August 14-15 following the heavy rains from the 11th to 13th, in the vicinity of Quincy, Ill., Hannibal and Louisiana, Mo., caused flood conditions in the creeks and the small rivers of this vicinity that resulted in a great amount of damage.

Bear Creek, at Hannibal, overflowed the bottoms from Oakwood nearly to Main Street and it is estimated that nearly 500 people were driven from their homes; many had to be rescued, some in boats. Water came into many houses, probably causing \$1,500 damage to furnishings and the cost of cleaning. Most of the damage was from water and mud. The water was not so high and the damage was less than in the flood of July 29, 1910.

The C. & O. R. R. lost bridges and dumps, from below Quincy to Elsberry, Mo., that it will cost \$150,000 to replace, and the St. L. & H. R. R. loss will amount to \$49,000. More bridges and dumps were washed out in this flood than at any one time in many years.

Train service from Hannibal to St. Louis was suspended from the morning of the 15th to the 20th, though one or more trains were run to Louisiana on the 19th.

In Marion, Monroe, Ralls, and Pike Counties, Mo., much damage was done to highways and bridges.

Other floods.

Flood warnings were issued for the Pecos River of west Texas on the 8th and again on the 23d, and for points on the Arkansas in eastern Colorado on the 21st. Beyond the flooding of bottom lands these floods caused no material damage.

Heavy local rains on the 10th, especially in north-central Illinois, caused washouts on the railroads of that section but the damage was quickly repaired.

Flood losses, August, 1916.

Buildings, railroads, telegraph and telephone lines (West Virginia).....	\$575,000
Highways and bridges (Hannibal, Mo.).....	10,000
Buildings (Hannibal, Mo.).....	1,500
Crops, prospective (Hannibal, Mo.).....	8,000
Annual rise of Columbia, 1916:	
Railroads, highways, bridges, etc.....	7,640
Crops, gathered.....	3,600
Crops, prospective.....	3,680
Live stock, farm buildings, etc.....	600
Suspension of business.....	12,225
Total.....	622,245

Hydrographs for typical points on several principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

TABLE 2.—Floods in the East Gulf States during August, 1916.

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
		<i>Feet.</i>			<i>Feet.</i>	
West Pearl.....	Pearl River, La.....	12	1	7	14.2	126
Tombigbee.....	Demopolis, Ala.....	39	1	2	66.2	116
Flint.....	Bainbridge, Ga.....	25			23.9	1
Ocmulgee.....	Abbeville, Ga.....	11	1	4	14.1	128
Do.....	do.....	11	9	10	11.5	9
Do.....	Lumber City, Ga.....	15	1	1	16.2	130
Do.....	Macon, Ga.....	18			16.6	3

¹ Occurred in July.

TABLE 3.—Floods in the South Atlantic States during August, 1916.

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
		<i>Feet.</i>			<i>Feet.</i>	
Edisto.....	Edisto, S. C.....	6	1	3	6.8	131
Saluda.....	Chappells, S. C.....	14			12.4	2
Santee.....	Rimhill, S. C.....	12	1	15	35.8	120
Do.....	Ferguson, S. C.....	12	1	19	24.7	122
Black.....	Kingstree, S. C.....	12	1	5	15.5	117
Lynches.....	Ellingham, S. C.....	14	1	4	15.0	3
Waccamaw.....	Conway, S. C.....	7	1	14	9.2	1
Cape Fear.....	Elizabethtown, N. C.....	20	1	1	27.4	128

¹ Occurred in July.

TABLE 4.—Floods in various other rivers during August, 1916.

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
		<i>Feet.</i>			<i>Feet.</i>	
Holston, North Fork.....	Mendota, Va.....	8	16	16	14.0	16
Columbia.....	Marcus, Wash.....	24	1	6	33.8	15
Do.....	Vancouver, Wash.....	15			14.8	1
Willamette.....	Portland, Oreg.....	15			14.3	1

¹ Occurred in July.

FLOODS IN THE EAST GULF AND SOUTH ATLANTIC STATES, JULY, 1916.

By ALFRED J. HENRY, Professor in Charge.

[Dated: River and Flood Division, Weather Bureau, Sept. 20, 1916.]

The immediate cause of the destructive floods in the East Gulf and South Atlantic States was the movement over those States of two tropical cyclones, whose approximate paths are shown in figure 1 (XLIV-93).¹

The first of these storms passed inland over the Mississippi coast during the night of July 5-6, 1916, and moved slowly a little west of north to about the thirty-second parallel of north latitude, thence it followed a somewhat sinuous course a little east of north for several days, finally by the morning of July 11 it had become a disturbance of such feeble intensity that its future course could not be followed. In its movement over the State, which occupied practically all of five days, rain fell almost continuously; in some parts of the State, as will appear

from the daily rainfall charts which accompany this report, figures 3-14 inclusive, the rainfall was extraordinarily heavy. As this storm drifted over northern Alabama and eastern Tennessee its sphere of influence extended across the Appalachians into the Carolinas, the mountain districts of which received heavy rains.

Almost immediately a second tropical cyclone moved in from the Atlantic, passing over the coast of South Carolina on the morning of July 14, 1916. During that day torrential rains fell on the lowlands a short distance northeast of Charleston, attended by high winds. By the morning of the 15th the center of the storm had reached western North Carolina. Beginning in the afternoon of that day and continuing for 24 hours, unprecedented rains fell over the eastern slope of the Blue Ridge and also in the valley of the French Broad as it flows northward between the several parallel ranges of the Blue Ridge. The run-off from these rains by reason of the saturated condition of the soil must have been 80 or 90 per cent of the precipitation. Naturally floods hitherto unprecedented occurred in both the Tennessee and Atlantic drainage, as will appear later in this report.

When tropical cyclones move into extratropical latitudes they generally retain some of the characteristics which differentiate them in the beginning from extratropical cyclones. The precipitation of a tropical cyclone is torrential in character and rather uniformly distributed around the center of the storm. In extratropical cyclones the precipitation is not uniformly distributed about the center, but the maximum amount is generally found over the southeastern quadrant some little distance from the center. A common characteristic of extratropical cyclones is that whenever the rate of progression of the storm is retarded the cumulative precipitation in its path generally exceeds the so-called excessive rate.

Whether the extraordinary rains of the East Gulf and South Atlantic States were due to the fact that tropical storms passed over them, or whether the rains would not have been equally heavy had the storm been of extratropical origin is not a question of material importance. The writer is inclined to the opinion that the distribution of the precipitation in connection with these two storms is such as might be expected from an extratropical cyclone following the identical paths pursued by the tropical cyclones shown on figure 1. This belief is strengthened by the fact that the floods of August, 1908, in South Atlantic States, floods that are generally recognized as being hitherto the most severe of record in those States, were due to a rather feeble extratropical cyclone that advanced slowly from southern Alabama on August 24, 1908, to the Atlantic off Cape Hatteras on August 27.

The record of rainfall in connection with both storms is included in Table 3 and the areal distribution is illustrated in a series of charts, figures 2-17. The scale of the charts is about 110.5 miles to an inch. It is a matter of regret that it was not possible to present charts on a much larger scale. A casual inspection of these charts will show that during the early period of both storms there were isolated areas, or islands, of exceptionally heavy rains within a general area of moderate rains. Such islands appear on the chart for the 6th, figure 3 for example, in southeastern Mississippi, south-central Alabama, and extreme northwestern Florida. The island in southeastern Mississippi is the greatest in superficial extent, covering parts, if not all of the counties of George, Perry, Greene, and Jones in Mississippi, and portions of Washington and Mobile Counties in Alabama.

¹ Accompanied by Charts XLIV-93 to XLIV-110, presenting figures A. J. H. 1-20.